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MAGNATRAN Pre-Submission Public Meeting

June 19, 2012

Agenda

- Introduction/Opening Remarks
- General Overview of MAGNATRAN Licensing Activities
- Presentation of MAGNATRAN SAR Structure
- Structural and Thermal Overview
- Shielding and Criticality Overview
- Request for Supplemental Information
- Schedule Requirements
- Questions/Comments

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Slide 1

Introduction/Purpose of Meeting

- Provide a pre-submission overview of MAGNATRAN original submittal content for unique issues/solutions
- Present resolution of nonproprietary RSI and general observation questions
- Discuss schedule requirements

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Overview of MAGNATRAN Application

- Standard PWR and BWR Basket Configurations
- PWR Damaged Fuel Basket Configuration
- Zion Pool Inventory
- GTCC

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MAGNATRAN SAR Document Structure

- Docket Number 71-9356
- MAGNATRAN Application, Revision 12A
- Nonproprietary and Proprietary Format
  - Nonproprietary Version
  - Proprietary Version
- Application to include RSI and General Observations responses as an enclosure

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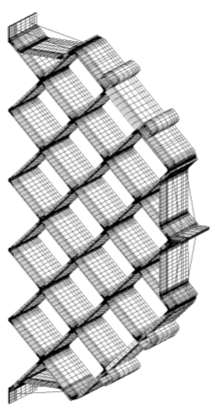
Transport Basket Structural Evaluation

PWR Model (45° orientation)



- Pin-slot model uses increased mesh density
- Boundary condition: Canister shell displacements:
  - Use a full-length canister model to incorporate the end effect of the canister
  - Canister shell displacements are based on transport conditions

PWR Basket Factors of Safety

Component	P+Q Stress	30-foot Drop
Fuel tube	1.20	1.12
Weldment	2.35	1.10

BWR Basket Factors of Safety

Component	P+Q Stress	30-foot Drop
Fuel tube	1.26	1.10
Weldment	2.64	1.13

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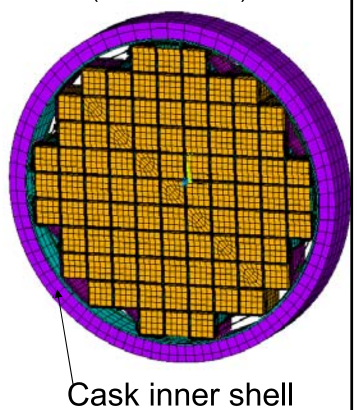
Transport Basket Structural Evaluation (cont'd)

- LS-DYNA Basket stability evaluation uses the same methodology as for storage
- The max gap between tubes is the same as for storage
- Multiple orientations are evaluated
- Stability model uses the same weldment model as used for the storage stability analysis
- Stability is confirmed by evaluating system at accelerations & mass greater than maximum drop accelerations by 1.43

BWR basket stability model (0° orientation)



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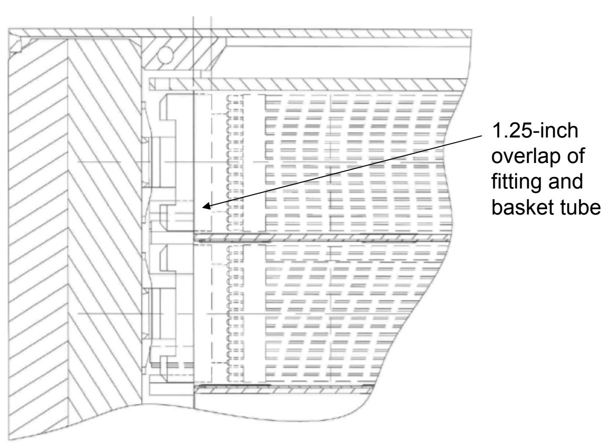
ITTR Evaluation

- Lower section of upper end fitting is within the basket slot for the bounding condition of the fuel assembly having a BPRA, thimble plug or RCCA



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ITTR Evaluation (cont'd)

- Fuel rods are captured under normal loads to maintain rod confinement position with nozzle attachment – guide tubes are not required for maintaining assembly configuration.
- For side impact the nozzle weight is carried by the basket tube wall as a distributed load.
- For bottom-end impact the nozzle is aligned with the assembly developing a compression load from the nozzle distributed over the existing guide tubes similar to the undamaged fuel configuration. There is no change in fuel rod structural performance.
- Top–end impact develops a compressive load of fuel weight on the nozzle plate. Fuel rod structural loads are the same as the undamaged fuel configuration.

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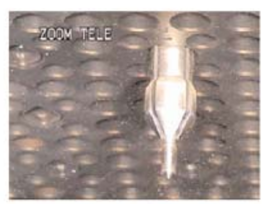
ITTR Assembly

(ref. Westinghouse April 2008 NS-FS-0097 (75370))

ITTR, top portion

ITTR, bottom portion



Bottom portion of the ITTR (ITTR and expansion rod are visible)

Completed ITTR installation

A completed installation and thimble plug (ITTR is visible in the center of the hub)

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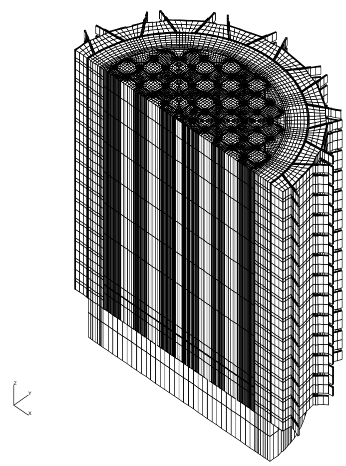
Transport Thermal Evaluation

- Use effective properties methodology for fuel and neutron absorber
- Fuel thermal conductivities are reduced based on guidance from IN 2009-23
- Design basis heat loads:
  - PWR: 23 kW
  - BWR: 22 kW
- Copper fins are in direct contact with the cask body and act as thermal shunts through the neutron shield



BWR symmetry model

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Transport Application Shielding Scope

- MAGNASTOR canister and basket with transport cask overpack
- Maximum assembly average burnup
  - PWR fuel at 70 GWd/MTU
  - BWR fuel at 60 GWd/MTU
- Contents analyzed to meet decay heat and 10 CFR 71 dose rate limits
  - PWR heat load – 24 kW
  - BWR heat load – 23 kW
  - GTCC – 1.7 kW
- No credit taken for increased shielding associated with the DFC cell plates (1.25-inch inner plate and 0.75-inch outer plate).
- Undamaged fuel (PWR/BWR) and damaged fuel (PWR only)
  - PWR fuel with nonfuel hardware

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Analysis Method

- SCALE 4.4 source term – extracted from MAGNASTOR licensing calculations
- MCNP5 shielding analysis considering streaming paths
- Dose rates calculated with response function (i.e., individual energy line dose response calculated and multiplied by source spectrum)
  - Confirmed to be acceptable by full spectrum calculations and comparisons
- Overall analysis approach and analysis tools identical to MAGNASTOR

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Analysis Method (cont’d)

- Complete calculation sets for PWR damaged and undamaged contents, BWR undamaged contents, GTCC waste
- Considered fuel compaction in damaged fuel locations
  - Increased fuel density within “undamaged” assembly active fuel region
  - Fuel migration into nonfuel region (end-fitting and plenum regions)
  - No damaged fuel in “long” PWR TSC

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Primary Nonfuel Hardware Contents

- MAGNATRAN Application, Rev. 12A
  - Combined list of MAGNASTOR FSAR, Rev. 0 and Amendment 3
- MAGNASTOR FSAR, Rev. 0
  - Burnable poison rod assemblies
  - Thimble plugs
  - Reactor control elements (CEAs, RCCAs)
- MAGNASTOR, Amendment 3
  - Hafnium flux reduction/shield assemblies (HFRA)
  - Primary and secondary neutron source assemblies (NSA)
  - Activated stainless steel rods (reconstituted assembly)

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Transport Application Shielding Results

- Minimum cool time set to meet 10 CFR 71 dose limits while not exceeding system design basis heat load. Therefore, multiple fuel assembly/burnup/cool times produce bounding 2 meter configurations
- Reduced > 45 GWd/MTU burnup allowed heat load by 5% (consistent with MAGNASTOR) without crediting reduced source in shielding analysis
- Bounding dose rates (maximum dose rate at < 2m meter tally locations) produced by undamaged fuel configuration
  - Undamaged fuel in “long” TSC is closer to neutron shield to impact limiter transition, which is a streaming location (reduction in bulk shield)

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Transport Application Criticality Scope

- PWR and BWR undamaged fuel assemblies
- PWR damaged fuel assemblies
- PWR assemblies evaluated using burnup credit
  - Invokes additional benchmark/validation for criticality code (MCNP) and adds the validation for the depletion code (SCALE TRITON)
- BWR assemblies evaluated using fresh fuel assumption

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Criticality Code

- MCNP with ENDF-B/VI cross-sections (continuous energy)
- USL established for:
  - UO_2 criticals (USL=0.9372)
  - MOX criticals (USL=0.9331)
  - Spent fuel criticals (USL=0.9369)
- Apply depletion bias/bias uncertainty to lowest USL for an "effective" USL of 0.92571 for PWR burnup credit analysis
- Apply UO_2 critical USL of 0.9372 to BWR analysis (fresh fuel only – no burnup credit)

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Establish Maximum System Reactivity

- PWR and BWR basket at maximum reactivity configuration and moderator density
  - Basket tolerances
  - Mechanical perturbations in the system (i.e., component shift)
  - Potential reconfigurations as a result of cask drop accident evaluations (no effect on PWR system, but affects fuel locations relative to absorber for BWR system)
  - Cask condition (i.e., normal versus accident conditions, single cask versus array).

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Transport Cask PWR Criticality Evaluations

- Actinide only (basis ISG-8)
- Fission product margin evaluated but not bias adjusted
- Outline for transport cask criticality evaluations
  - Validation, bias and bias uncertainty calculations
    - TRITON/NEWT depletion calculation
    - UO_2, MOX, spent fuel MCNP calculation
- 37-assembly basket evaluation for generic inventory
- Site-specific evaluation for decommissioning plant

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Transport Cask PWR Criticality Evaluations (cont'd)

- Baseline analysis for undamaged basket at baseline 0.036 g/cm^2 ^{10}B absorber density
- Revised to account for under-loaded systems (36 and 33 assembly), reduced absorber density, and use of RCCAs to control system reactivity
- Damaged fuel analysis replicates the approach taken for undamaged fuel, but accounts for specific aspects of the DFC
  - Potential reconfiguration of fuel material
  - Revised basket geometry at DFC location
  - Potential for preferential flooding in DFCs

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Depletion Code

- SCALE 6 TRITON/NEWT using CENTRM
  - Validated against measured isotopics
  - Samples from seven sites
  - Depleted actinides from measured and calculated isotope sets placed into MCNP model

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Depletion Parameters

- PWR models depleted with a bounding assumption set based on ORNL/NUREG reports
  - Max hot leg temperature (610K)
  - Maximum soluble boron content (uniform 1000 ppm)
  - BPRA inserted for full credited burnup
  - Minimum 15-year cool time for undamaged fuel basket
  - CEA/RCCA insertion not modeled
    - 20 cm insertion allowed with no significant effect
    - Insertion up to 10 GWd/MTU bounded by BPRA model

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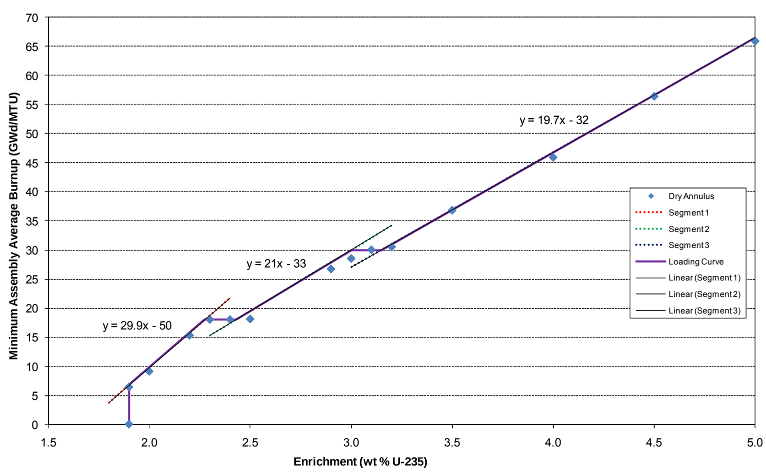
Maximum Reactivity Configuration (37-Assembly Basket) - WE15 Fuel Type



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Maximum Reactivity Configuration (37-Assembly Basket) - WE15 Fuel Type

Assembly ID	Zero (0) Burnup Maximum. Enrichment	Minimum Required Burnup (GWd/MTU) = C_1 × Enrichment (wt % ^{235}U) - C_2					
		Burnup (GWd/MTU) < 18		18 ≤ Burnup (GWd/MTU) ≤ 30		Burnup (GWd/MTU) > 30	
	(wt % ^{235}U)	C_1	C_2	C_1	C_2	C_1	C_2
CE14	2.1	28.8	55	20.1	35	18.3	31
CE16	2.1	31.8	62	20.2	37	19.3	35
WE14	2.2	26.4	52	18.5	36	17.1	33
WE15	1.9	29.9	51	21.5	36	19.2	32
WE17	1.9	29.9	50	21	33	19.7	32
BW15	1.9	28.8	47	21	34	19.1	30
BW17	1.9	30.2	51	23	40	19.2	31

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High Reactivity Fuel

- Evaluated for total inventory solution that must address high reactivity fuels – primarily one and two cycle burned fuel from last core that was "fully" enriched
- Analysis/licensing options:
  - Revise baseline analysis parameters
    - E.g., extend cool time, reduce soluble boron
  - Partial Load
    - Opens center basket locations where moderator produces large "flux trap" (36 and 33 assembly patterns)
    - Not sufficient for full inventory (in particular, one cycle burned fuel)
  - RCCA (New/Used)
    - Allow fresh fuel with RCCA inserted to compensate for lack of burnup credit (one/two cycle burned fuel)

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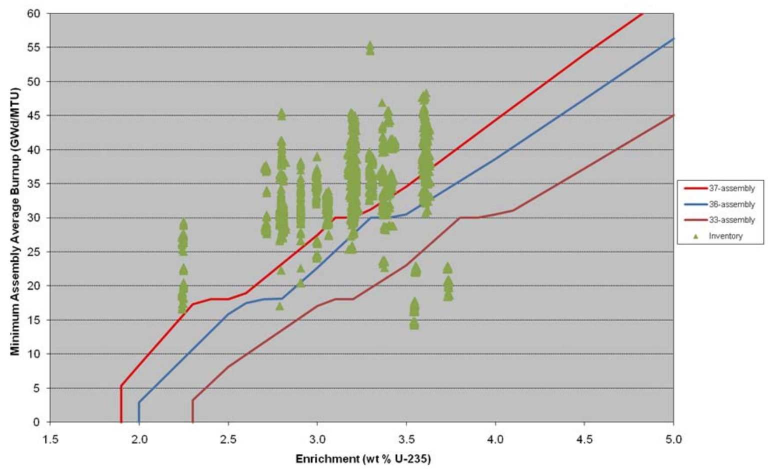
Inventory Effect of Partial Load



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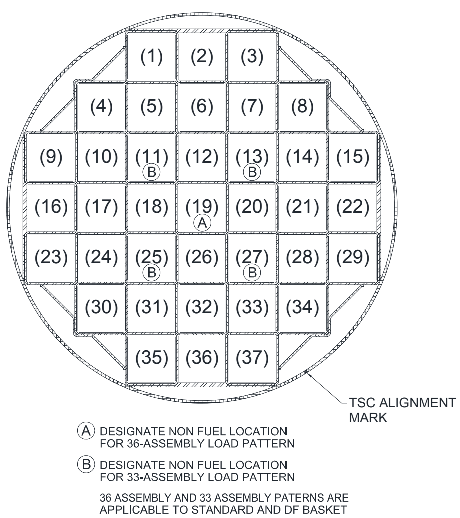
Partial Load Pattern



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Partial Load Required Burnup

# Assemblies	Zero (0) Burnup Maximum. Enrichment	Minimum required burnup (GWd/MTU) $= C_1 \times$ enrichment (wt% ^{235}U) - C_2					
		burnup (GWd/MTU) < 18		18 ≤ burnup (GWd/MTU) ≤ 30		burnup (GWd/MTU) > 30	
	(wt % -^{235}U)	C_1	C_2	C_1	C_2	C_1	C_2
37	1.9	20.9	34	20.3	34	17.7	28
36	2.0	28.9	55	18.7	34	17	31
33	2.3	23.3	50	16.8	36	14	27

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RCCA Use for Reactivity Suppression

- Depleted RCCAs still contain a significant amount of reactivity worth
- RCCA rodlets fully inserted/supported by guide tubes
- Absorber extend majority of active fuel length (absorber region 142 inches versus 144-inch fuel length)
- Depleted using TRITON/NEWT at full assembly power/ assembly burnup
  - Significantly conservative as full RCCA insertion was not allowed at Zion during full power operations
  - Limited insertion from two banks was permitted, but significant insertion not typical for core operation
- Allows transport of ~4 wt % fresh fuel

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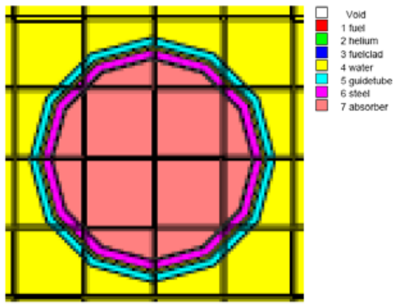
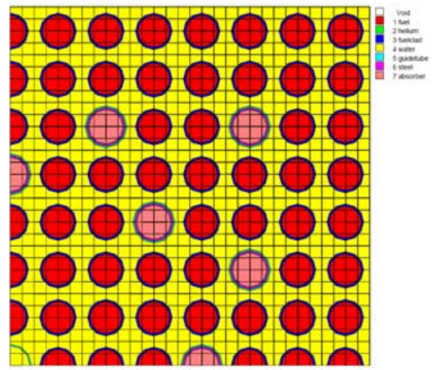
RCCA Model for TRITON/NEWT Depletion





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Damaged Fuel Transport and Burnup Credit Analysis

- Undamaged fuel evaluations/storage calculation repeated, but with low burnup material in damaged fuel location
  - Damaged fuel inserted a minimum one cycle of core operation
  - Analysis assigned 3.8 wt % enriched fuel with a minimum burnup of 5 GWd/MTU to DFC content to account for profile shape and hypothetical rearrangement of fissile material
  - 20-year cool time
- Evaluate rod pitch, missing rod and clad/fuel material reconfiguration in DFC location
- CSI increased to 100 (single cask) to account for increased reactivity associated with preferential flooding

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Damaged Fuel Loading Curve Summary – 0.036 g/cm^2 ^{10}B

Assembly ID	Zero (0) Burnup Maximum. Enrichment	Minimum required burnup (GWd/MTU) = C_1 × enrichment (wt% ^{235}U) - C_2					
		Burnup (GWd/MTU) < 18		18 ≤ Burnup (GWd/MTU) ≤ 30		Burnup (GWd/MTU) > 30	
	(wt % -^{235}U)	C_1	C_2	C_1	C_2	C_1	C_2
CE14	1.9	17.1	24	18.6	29	17	24
WE14	1.9	22	39	17.4	31	16.6	31
WE15	1.6	22.5	29	18.9	25	19.2	27
WE17	1.6	31	45	20.2	27	18.4	23
BW15	1.6	22	28	17.8	21	17.6	21
BW17	1.6	27.5	41	18.6	25	17.3	22

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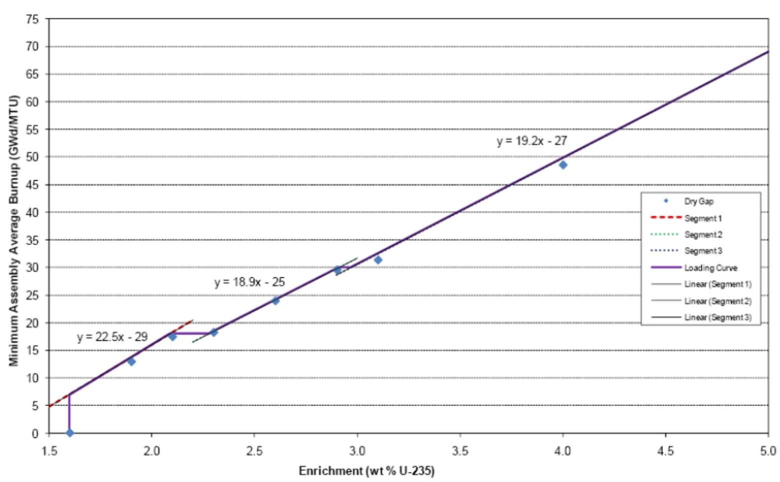
Damaged Fuel Loading Curve WE15 - 0.036 g/cm^2 ^{10}B



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Fuel Burnup Measurement

- Alternative to ISG-8, Rev. 2
  - MAGNATRAN loading curves to invoke requirements that differ from ISG-8, Rev. 2
  - Requirements to rely on accuracy of reactor records with uncertainty applied in conjunction with:
    - Audit/confirmation of reactor records and tracking from in-core assembly burnup calculations to current pool location
    - Verification of no fresh fuel located in pool prior to loading
    - Verification of high reactivity fuel locations prior to and post-loading
    - Measurement of any assemblies that cannot be concluded as having appropriate documentation (e.g., identification number not available). Currently not expected to be required at the Zion site.

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Burnup Uncertainties/High Burnup

- Burnup Credit Loading Curves
  - No uncertainty to reactor data assigned within SAR
  - Application of burnup record uncertainty dependent on quality/accuracy of plant records (based on literature, a 5% value may be considered “default” for standard PWR inventory – excludes first generation reactors)
  - Potential on a site-specific basis to reduce uncertainty to a lower value (>2%)
- High Burnup Classification
  - Currently, ISG-11 states “assemblies with average burnups exceeding 45 GWd/MTU”
  - Use of nominal (reactor record) assembly average burnup for classification of high burnup fuel

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Transport Cask BWR Criticality Evaluations

- Fresh fuel assumption (i.e., no burnup credit)
- Analysis method in determining maximum reactivity configuration and allowed enrichments similar to MAGNASTOR application
  - Determined maximum reactivity tolerances and component location
  - Applied combined model in maximum reactivity cask configuration (loss of neutron shield) to determine maximum allowed enrichment
  - Difference to storage application is the result of fuel movement as a result of cask end-drop

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Transport Cask BWR Criticality Evaluations (cont'd)

- Cask drop effect
  - Deformation of BWR bale (handle)
  - Movement of fuel into plenum region
  - Combined moves fuel out of absorber coverage sufficiently to result in a slight increase in reactivity, resulting in lower allowed enrichments
  - Analysis compensated by considering axial end-blankets (unenriched)

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Request for Supplemental Information (RSI)

- Number of RSI to be addressed by category/ discipline:
  - General Information – 3
  - Structural & Materials Evaluation – 3
  - Thermal Evaluation – 7
  - Shielding Evaluation – 3
  - Criticality Evaluation – 6
  - Operating Procedures Evaluation – 1
  - Acceptance Tests & Maintenance Evaluation – 1
- A total of 17 Observations (by category/discipline) also to be addressed

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Project Schedule Requirements

- Submission of MAGNATRAN Application 2 – 3 Weeks after 6/19/2012 Pre-submission Meeting
- Desired MAGNATRAN CoC by 12/31/2013

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Questions/Comments

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